

Reduction of Private Vehicle Usage in Response to Fuel Price Rise: A Comparison between Automobile Drivers and Motorcycle Riders

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Abstract: This study developed a model to describe the relationship between the agents of socialization, personal norm of using environment friendly traveling mode, and private vehicle usage reduction in response to fuel price rise. An empirical study was conducted by using the measurement data collected from 209 participant automobile drivers and 565 participant motorcycle riders. The study results show that the models for automobile drivers and motorcycle riders are different and should be estimated individually. The private vehicle usage reduction is found to be significantly determined by personal norm for both automobile drivers and motorcycle riders, and agents of socialization have different influences on personal norm for automobile drivers and motorcycle riders. Automobile drivers consistently have higher willingness than motorcycle riders to reduce their private vehicle usage reduction on the trips for all activities in response to fuel price rise. Some suggestions were derived from study results to reduce the vehicle usage for automobile drivers and motorcycle riders.

Keywords: private vehicle usage, automobile driver, motorcyclist, personal norm, fuel price rise, structural equation modeling.

1. INTRODUCTION

Carbon dioxide (CO₂) is one of the major anthropogenic greenhouse gases (GHG) that change our circumstance. Transport sector is one of the important sources of CO₂ emission, especially for private vehicle usage (Brand & Preston, 2010). According to the study results of Environmental Protection Administration (Executive Yuan, Taiwan, 2006), a car with 2000c.c. produced 81 gram of CO₂ per kilometer traveling and a motorcycle with 100-125c.c. produced 23 gram of CO₂ per kilometer traveling averagely. Though a motorcycle seems to produce less CO₂ emission than a car, however, those two types of private vehicle really produce much higher CO₂ emission than public transportation per unit of passenger-mile transportation. Motorcycles are popular private vehicles in Asian countries. Sales of motorcycle in many Asian countries are ranked top 10 in the world in the past decade, such as China, India, Indonesia, Vietnam, Thailand, Philippines (Automotive Research & Testing Center, 2012). Thus, in order to reduce the CO₂ emitted by private vehicles, the management strategies should be applied to both motorcycle and car usage reduction in most Asian countries.

Private vehicles usage reduction is a universal issue and many countries in the world have applied a lot of promotion strategies to encourage public transportation usage. However, the achievement of those efforts is still very limited. Therefore, many studies have started to focus their efforts on exploring the effect of travelers' characteristics on personal vehicle usage, especially the psychological determinants to make their mode choice decisions. Personal norm was found by Bamberg et al. (2007) to be an important psychological factor that affects travelers' mode choice. People's norms have been developed since childhood under socialization that is the process an individual learns about how to appropriately position himself/herself in a society. Traveling is a behavior that needs to interact with other people,

thus Baslington introduced the theory of “travel socialization” to delineate how and why people make their mode choice decisions (2008). Baslington argued the way children learn about travel mode usage is similar to the culture developed in a society. Thus, the three major agents of socialization -- family, school, and peer group, are expected to have their influential effect on people’s traveling mode usage.

Many studies have been conducted to investigate the relationship between agents’ attitude and travelers’ mode usage. They found that parents’ belief in traveling mode usage, such as “a car is necessary in my life” and “driving will save me much time” (Tinsley, 1997; Maxwell, 2001), will affect children’s conception and behavior on traveling mode usage when they grow up. Chinn et al. (2004) found that teenagers really care about how their peer groups regard their behavior. Baslington (2007) also indicated that teenagers might have some peer-oriented behaviors to obtain the feeling of independence. Children learn social rules from other people to know how to do is appropriate, and cumulate their beliefs to judge whether it is right to do some things, which is personal norm (PN). Schwartz (1977) introduced the norm-activation model (NAM) and defined PN as the moral feelings to make behavioral decision in accordance with an individual’s personal value. PN is a direct predictor to pro-social behaviors and determined by the establishment of problem awareness or awareness of consequence (ACE). Many studies indicate that PN has positive effect on using a traveling mode that is friendly to environment (Hunecke, et al., 2001; Nordlund & Garvill, 2003).

Previous studies concerning the effect of personal norm on vehicle usage were commonly applied to car usage. Very few studies were concentrated on the effect of personal norm on motorcycle usage. In Taiwan, motorcycles play an important role for people’s daily traveling and bring a lot of environmental and traffic safety problems to the society. Under the policy of encouraging public transportation usage, how to reduce the car and motorcycle usage is becoming a challenging issue for the development of transportation system in Taiwan. Among the policies to reduce private vehicle usage, increasing fuel price is usually considered as a priority strategy due to simplicity, and thus needs to consider its possible efficiency carefully before implementation.

Therefore, this study was conducted to develop an approach to exploring how the policy of fuel price rising affects people’s reduction on private vehicle usage, including both automobile and motorcycle usage reduction. This study started with developing a structural model to formulate the relationship between the agents of socialization, personal norm of using environment friendly traveling mode, and private vehicle usage reduction in response to fuel price rise. According to previous study results, a conceptual model was established as shown in Fig 1. Presumably, participants’ private vehicle usage reduction in response to fuel price rise (abbreviated as UR) is positively determined by personal norm of using environmental friendly traveling modes (abbreviated as PN), and PN is positively determined by multi-mobility in peer group (abbreviated as MM-PEER) and awareness of consequence (abbreviated as ACE) but negatively determined by parents’ attitude toward vehicle usage (abbreviated as PA). An empirical study was then conducted by using the data collected from car and motorcycle users in Taiwan. Some strategies to reduce private vehicle usage are suggested based on the findings obtained from developed model and further investigation on participants.

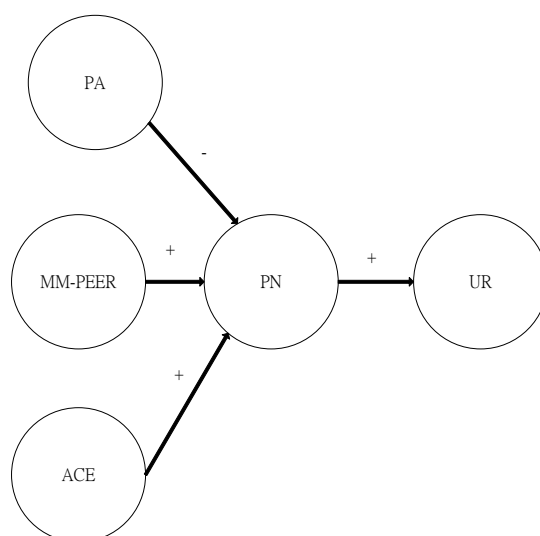


Fig 1. A Structural Model for Private Vehicle Usage Reduction

2. METHODS

To measure the latent variables which we are interested, the applicable items for suitable scales are drawn and designed through reviewing the literature and making some modifications. Then, the participants are invited to fill the scales and collect sufficient data for empirical study. Some statistical analysis works, including correlation among the variables, multi-group confirmatory factor analysis, and goodness tests are conducted to verify the developed model is appropriate for model estimation.

2.1 Instrumentation

According to the proposed structural model, five latent variables are required to be properly measured through questionnaire design. These five scales include: (1) reduction of car/motorcycle usage in response to fuel price rise (UR); (2) personal norm of using environmental friendly traveling modes (PN), (3) parents' attitude toward car/motorcycle usage (PA), (4) peers' attitude toward car/motorcycle usage (MM-PEER), (5) establishment of awareness of consequences in school (ACE). The items of each scale for automobile drivers and motorcycle riders are the same, but the mode referred in the item is different. For example, "Would you reduce your car use in the following trips..." is designed for automobile drivers, and "Would you reduce your motorcycle usage in the following trips..." is designed for motorcycle riders. The items in the questionnaire are designed to catch the information for separate latent variables which would be used to verify the developed theoretical framework of private vehicle usage reduction in response to fuel price rise by applying a statistical analysis of structural equation model (SEM). These latent variables embedded in the questionnaire are introduced as follows:

- (1) Car/motorcycle use reduction (UR) in response to fuel price rise

In order to catch participants' private vehicle usage reduction, several measuring scales related to car dependency, car usage, and response frequency measure (RFM) (Chang and Wu, 2008; Haustein et al., 2009; Lois, 2009; Steg, 2005; Steg et al., 2001; Verplanken et al., 1994) were referred. Finally, nine types of common daily trip for various activities were chosen as the items to reflect participants' degrees of intention to reduce their private vehicle usage in response to fuel price rise. These nine types of common daily trip are: (1) trips for commuting;

(2) trips for work or business visit; (3) trips for multi-stop activities; (4) trips for recreational activities; (5) trips for shopping; (6) trips with time pressure (not including commuting); (7) trips for occasional travel requirements; (8) trips for non-destination cruising around the streets without any specific purpose; and (9) trips for sending/taking family members. The questions are designed as “How much will you reduce your car/motorcycle usage for following different trips (i.e. designed items) when the gasoline price increases 15% (from NT\$ 34.8 per liter up to NT\$ 40 per liter)?” The participants were asked to answer the question with a six-point Likert scale, ranging from 1 (no reduction) to 6 (will not use car/motorcycle any more), according to their personal feeling.

(2) Personal norm (PN) toward environmental friendly traveling modes

The scale of personal norm toward environmental friendly traveling modes is designed to measure the degree of personal feeling of moral responsibility to use environmental friendly traveling modes. This scale was developed after referring related literatures and making some modifications (Bamberg et al., 2007; Blöbaum et al., 2004; Haustein et al., 2009;). Three items are included in this scale. They are (1) I feel guilty to drive a car/motorcycle to work/school whenever the environmentally friendly transportation modes are available; (2) I feel obliged to drive a car/motorcycle as less as I can; (3) environmental protection is deeply considered when facing a mode choice decision. The participants were asked to answer the questions with a six-point Likert scale, ranging from 1 (totally disagree) to 6 (totally agree), according to their personal opinions. Thus, the higher responsibility to use environmental friendly traveling modes one has, the higher PN score he/she will have.

(3) Parents' attitude (PA) toward car/motorcycle usage

The scale of parents' attitude toward car/motorcycle usage is designed to measure the influence of agents of socialization. This scale was developed by referring related studies and making some minor revisions (Baslington, 2008; Haustein et al., 2009). Two items are included in this scale. They are (1) my parents think that a car/motorcycle is very important for them to work; (2) my parents think a car/motorcycle is necessary for their daily life. The participants were asked to answer the questions with a six-point Likert scale, ranging from 1 (totally disagree) to 6 (totally agree), according to their personal opinions.

(4) Multi-mobility in the peer group (MM-PEER)

The multi-mobility in the peer group scale is designed to measure peers' attitude toward environmental friendly traveling modes for participants. This scale was developed by two items referred from the research introduced by Haustein et al (2009). These two items are (1) In my peer group we weighed up pros and cons of different travel modes when we wanted to get somewhere before I was 18 years old; (2) In my peer group we deliberately decided between alternatives when choosing a travel mode before I was 18 years old. The participants were asked to answer the questions with a six-point Likert scale, ranging from 1 (totally disagree) to 6 (totally agree), according to their personal feeling. The higher MM-PEER score one has, the more peers' influence on environmental friendly traveling mode choice the participant will have.

(5) Establishment of awareness of consequences in school (ACE)

The scale of establishment of awareness of consequences in school is designed to measure the degree of awareness of consequences when participants were in school (before 18 years old). This scale was developed by five items referred from the studies of Baslington (2008) and Haustein et al.(2009). These five items are (1) My teachers taught me the issues of environmental prevention before I was 18 years old; (2) My teachers taught me that we

couldn't waste gasoline because it would be used up before I was 18 years old; (3) My teachers taught me the noise impact of using a car/motorcycle before I was 18 years old; (4) My teachers taught me that the emission produced by using a car/ motorcycle would make global warming before I was 18 years old; (5) My teachers taught me the ecological impact of using a car/ motorcycle before I was 18 years old. The participants were asked to answer the questions with a six-point Likert scale, ranging from 1 (totally disagree) to 6 (totally agree), according to their personal experience.

2.2. Data collection

The subjects in this study include two groups -- automobile drivers and motorcycle riders. Thus, the participants were invited and interviewed randomly at some service areas for automobile drivers and motorcycle riders, such as gas stations, rest areas of national freeway system, automobile administration office et al., in December of 2012 in Taiwan. The screening criteria for participant private vehicle users include: (1) the participants should be aged over 18; (2) the participants should hold a valid automobile/motorcycle driving license; (3) the participants have been driving during the past month; and (4) the participants should have over 50% of chance to drive a car or ride a motorcycle when they go out. The last screening criterion was used to assure the participants are highly dependent on automobile or motorcycle for traveling, not those who only use automobile or motorcycle occasionally. Besides, the participants are asked to provide their demographic data.

2.3. The procedure of statistical analysis

The procedure of this empirical study includes three steps. First, we observed the correlations among the latent variables for automobile drivers and motorcycle riders separately to see whether the patterns of correlation are similar for these two study groups. And, then, the multi-group confirmatory factor analysis is used to check whether the differences between automobile drivers and motorcycle riders exist. If the differences of latent variables between two study groups really exist, the structural models will then be estimated separately and compared for automobile drivers and motorcycle riders.

3. STUDY RESULTS

3.1 The characteristics of participants

A total of 774 effective participants were interviewed, including 209 automobile drivers and 565 motorcyclists. Among the participants, 53.7% of them were male and 46.3% were female. The ages of the participants were ranged from 18 to 64 with an average of 33.32 years and about 80% of the participants were aged from 21 to 40. Further statistics about the participants' background for both automobile drivers and motorcycle riders are showed separately in Table 1. Among the participant automobile drivers, 55% were male and 45% were female. They were aged from 18 to 64 with an average of 36.22 years and about 69% of them were aged from 21 to 40. Furthermore, more than 80% of the participant automobile drivers were educated with a college degree or above.

As to participant motorcycle riders, 53% of them were male and 47% were female. The ages of participant motorcycle riders were ranged from 18 to 62 with an average of 32.25 years and 83% of them were aged from 21 to 40. Furthermore, more than 80% of the participant automobile drivers were educated with a college degree or above. Comparing the gender and age distributions of participant automobile and motorcycle users with those of their population, no significant differences between them were found. It appears that the participants could appropriately represent their population and the study results derived from them would be reliable with reasonable confidence.

Table 1. Background information for participant automobile drivers and motorcycle riders

	Automobile Drivers	Motorcycle Riders
Category	No. of Respondents (column percentage)	No. of Respondents (column percentage)
Gender		
Male	115(55.0)	301(53.3)
Female	94(45.0)	264(46.7)
Age		
18-20	0(0.0)	8(1.4)
21-30	36(17.2)	213(37.7)
31-40	108(51.7)	257(45.5)
41-50	54(25.8)	71(12.6)
51-60	9(4.3)	13(2.3)
Education		
Senior high school and under	29(13.9)	88(15.6)
College/university	146(69.9)	396(70.1)
Master's and above	34(16.2)	81(14.3)
Total	209(100.0)	565(100.0)

3.2 Correlation among latent variables

According to the objective of this study, we need to verify whether the theoretical framework about private vehicle usage reduction in response to fuel price rise is suitable for the participants before we start to compare the effects of gasoline price rise on private vehicle usage reduction for automobile drivers and motorcycle riders. Thus, we first computed the values of five latent variables based on the responding answers collected from 209 automobile drivers and 565 motorcycle riders, and examined the correlations among these five latent variables for the two groups separately. The mean values of five developed latent variables for automobile drivers are ranged from 3.43 to 4.00, and the composite reliabilities of them are all higher than 0.7 (See Table 2). The correlation coefficients among these five developed latent variables are also shown in Table 2. Based on the statistics summarized in Table 2, the outcome variable of vehicle usage reduction (UR) is found significantly correlated with the predictor variable of personal norm (PN) with the correlation coefficient of $r = 0.33$, but it is not significantly correlated with parents' attitude toward private vehicle usage (PA), multi-mobility in peer group (MM-PEER), and awareness of consequence (ACE). The predictor PN is found significantly correlated with ACE ($r = 0.24$), but it is not significantly correlated with PA and MM-PEER. PA is significantly correlated with MM-PEER ($r = 0.50$), but it is not significantly correlated with ACE. Finally, MM-PEER is not significantly correlated with ACE.

Table 2. The means, reliabilities, and correlations for the latent variables of automobile drivers.

	1.UR	2.PN	3.PA	4.MM-PEER	5.ACE	CR	Mean(S.D.)
1.UR	1.00					0.848	3.68(1.63)
2.PN	0.33*	1.00				0.703	3.77(1.38)
3.PA	-0.05	-0.14	1.00			0.752	3.43(1.76)
4.MM-PEER	-0.07	0.02	0.50*	1.00		0.722	3.44(1.52)
5.ACE	0.19	0.24*	0.13	0.18	1.00	0.958	4.00(1.47)

CR: Composite reliability; S.D. Standard Deviation; * Significant at $\alpha = 0.01$.

On the other side, Table 3 shows the mean values of the five latent variables for motorcycle riders (ranged from 2.84 to 3.99), and the composite reliabilities of all latent variables are also higher than 0.7. Based on the correlation coefficients among the latent

variables in Table 3, UR is found significantly correlated with the predictor variable of personal norm (PN) with the correlation coefficient of $r=0.29$, but it is not significantly correlated with PA, MM-PEER, and ACE. PN is found significantly correlated with MM-PEER ($r=0.15$) and ACE ($r=0.25$), but it is not significantly correlated with PA. PA is significantly correlated with MM-PEER ($r=0.52$) and ACE ($r=0.16$), and MM-PEER is significantly correlated with ACE ($r=0.18$).

Table 3. The means, reliabilities, and correlations for the latent variables of motorcycle riders.

	1.UR	2.PN	3.PA	4.MM-PEER	5.ACE	CR	Mean(S.D.)
1.UR	1.00					0.923	2.84(1.66)
2.PN	0.29*	1.00				0.759	3.23(1.45)
3.PA	-0.10	0.03	1.00			0.705	3.30(1.68)
4.MM-PEER	0.03	0.15*	0.52*	1.00		0.789	3.13(1.43)
5.ACE	0.07	0.25*	0.16*	0.18*	1.00	0.965	3.97(1.55)

CR: Composite reliability; S.D. Standard Deviation; * Significant at $\alpha = 0.01$

In conclusion, the statistical results indicate that: (1) UR is highly correlated with PN for both automobile drivers and motorcycle riders, (2) PN is significantly correlated with ACE for both automobile drivers and motorcycle riders, and (3) PN is significantly correlated with MM-PEER for motorcycle riders but not for automobile drivers. It indicates that the effects of agents of socialization on car usage and motorcycle usage are different. Thus, we need further statistical investigation to verify whether the structural models for automobile usage reduction and motorcycle usage reduction in response to fuel price rising are the same. If they are not the same, then the developed structural equations models for these two study groups should be estimated individually.

3.3 Estimated results for developed model

The procedure of model estimation could be divided into two stages. The structure discrepancy of measurement model between automobile drivers and motorcycle riders was tested first to determine whether the models for two study groups should be estimated individually. Then, the model is checked to see whether the model is suitable for automobile drivers and motorcycle riders.

3.3.1 Estimated results of the model for automobile drivers and motorcycle riders

First, the multi-group confirmatory factor analysis was employed to test the cross-group factorial invariance between automobile drivers and motorcycle riders. The multi-group tests would examine whether the measurement model linking the observed variables to latent variables are identical across groups. The result shows the consistency of measurement model between automobile drivers and motorcycle riders is rejected with significance level of 0.05 (the chi-square statistic is 412.14 with degree of freedom 47). It indicates that the path coefficients of the model for two study groups are significantly different and should be estimated individually.

Second, the data collected from participant automobile drivers were applied to verify the paths of developed SEM. The estimated results indicate the chi-square statistic is 355.63 (with degree of freedom 182) and the hypothetical model is rejected at $\alpha = 0.01$. According to the studies of Hu & Bentler (1998) and Marsh & Hocevar (1985), the models with large sample size are likely to be rejected under chi-square test. Therefore, another three indexes which wouldn't be affected by sample size for checking the goodness of model fit are applied. They are Root Mean Error of Approximation (RMSEA), Standardized Root Mean Square of

Residual (SRMR), and Comparative Fit Index (CFI). The values of RMSEA and SRMR less than 0.08 and CFI greater than 0.90 are considered as the adequate criteria for model fit (Hu and Bentler, 1999; Bentler and Bonett, 1980; Bentler and Dugeon, 1996; Browne and KUReck, 1993). In this model, RMSEA = 0.07, SRMR=0.07, and CFI = 0.92, the results show the statistical adequacy of the developed model for automobile drivers. Figure 2(a) shows that PN has significantly positive effect on UR with the coefficient of correlation $b=0.34$, PA and ACE have their significant effects on PN with the correlation coefficients of $\beta = -0.20$ and $\beta = 0.27$ respectively, but MM-PEER(with $\beta = 0.06$) is not significantly correlated with PN. The amount of explained variance for UR is 11.9%.

The estimated model fit indexes for motorcycle riders show the chi-square statistic of 713.74 (with degree of freedom 182) rejects the hypothetical model at $\alpha = 0.01$, but the results of RMSEA = 0.07, SRMR=0.05, and CFI = 0.93 indicate again the statistical adequacy of the model for motorcycle riders. Figure 2(b) shows that PN has significantly positive effect on UR with the coefficient of correlation $b=0.29$, MM-PEER and ACE also have their significant effects on PN with the correlation coefficients of $\beta = 0.15$ and $\beta = 0.24$ respectively, but PA (with $\beta = -0.09$) is not significantly correlated with PN. The amount of explained variance for UR is 8.6%.

3.3.2 Description of the resulting model

Based on the estimated results for the developed model, we could verify that (1) the developed structural model is adequate for both automobile drivers and motorcycle riders, (2) PA would affect UR through PN only for automobile drivers, and (3) MM-PEER would affect UR through PN only for motorcycle riders, and (4) ACE would affect UR through PN for both two groups. It implies that three agents of socialization would affect personal moral feeling of using an environmental friendly traveling mode.

Parents' attitude toward using a car is found to have negative effect on children's personal norm of using environmental friendly traveling mode. That is, the higher PA one has, the less PN one will have. It implies that children will have less responsibility to use environmental friendly traveling modes if their parents have higher attitude toward private car usage. But for motorcycle riders, PA has no significant effect on PN. MM-PEER has positive effects on PN for motorcycle riders. That is, the more MM-PEER one motorcycle rider has, the higher responsibility he/she will have to use environmental friendly traveling modes. It implies that the motorcycle riders who have more discussion with their peer group about the decision making of mode choice will have more responsibility to use environment friendly traveling modes. However, for automobile drivers, MM-PEER seems not to affect PN significantly.

ACE has positive effect on PN for both automobile drivers and motorcycle riders. It means that the people who have learned more knowledge about the consequence and impact of private vehicle usage will have more responsibility to use environment friendly traveling modes. Finally, personal norm toward using environmental friendly traveling mode (PN) is found to have positive effect on private vehicle usage reduction in response to fuel price rise. That is, the more responsibility to use environmental friendly traveling modes one has, the more private vehicle usage reduction he/she will have in response to fuel price rise.

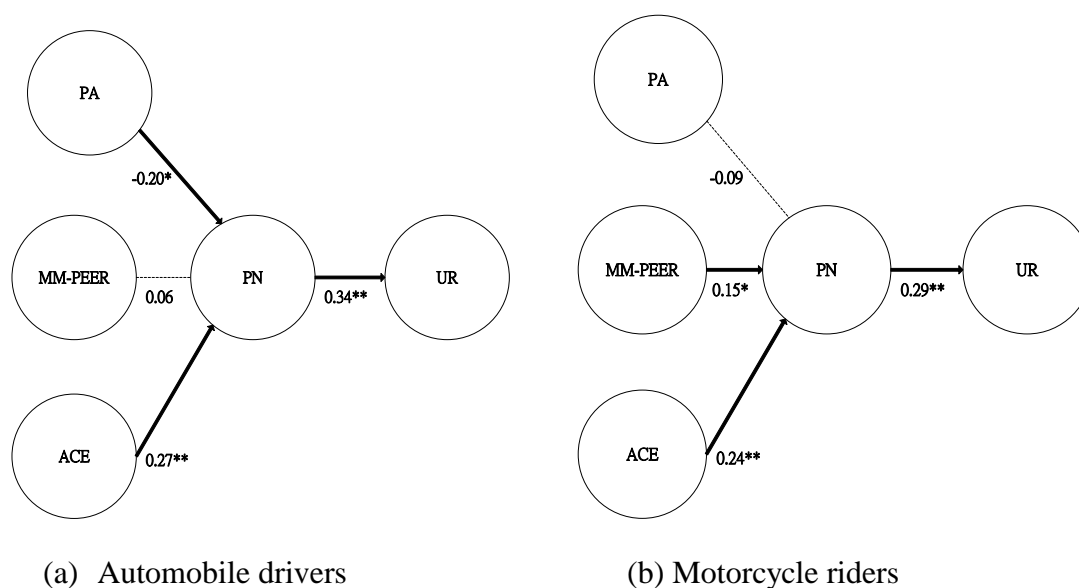


Fig 2. Estimated Results of Structural Equations Model (*p <0 .05; ** p<0.01).

3.4 Comparing the study results for two study groups

After assuring the path relationships among latent variables and verifying the adequacy of developed model, a further investigation was then conducted to explore the differences of personal norm towards environmental friendly traveling mode and private vehicle usage reduction in response to fuel price rise between automobile drivers and motorcycle riders.

3.4.1 The difference of PN between automobile drivers and motorcycle riders

The average values of latent variable for personal norm of using environmental friendly travel modes are 3.77 and 3.23 for automobile drivers and motorcyclists respectively (see Table 4). The mean value of PN for automobile drivers is significantly higher than that of motorcyclists. A further investigation on the individual items of latent variable PN also indicates that automobile drivers have significantly higher mean values for all PN items than motorcyclists at $\alpha = 0.01$. It implies that automobile drivers have higher personal norm of using environmental friendly traveling mode than motorcyclists and are expected to reduce their automobile usage more than motorcyclists in response to fuel price rise.

Table 4 Comparisons of PN difference between automobile drivers and motorcyclists

Items for personal norm for private vehicle usage	Mean Score(S.D.)	
	Drivers	Riders
I feel guilty to drive a car/motorcycle to work/school whenever the environmentally friendly transportation modes are available	3.20*(1.39)	2.68(1.42)
I feel obliged to drive a car/motorcycle as less as I can	4.20*(1.24)	3.45(1.40)
Environmental protection is deeply considered when facing a mode choice decision	3.92*(1.31)	3.55(1.36)
Mean score of latent variable for personal norm	3.77*(1.38)	3.23(1.45)

* Significantly higher at $\alpha = 0.01$

3.4.2 Private vehicle usage reduction in response to fuel price rise for different groups

The mean value of the latent variable of private vehicle usage reduction (UR) in response to fuel price rise for automobile drivers (3.68) is significantly higher than that of motorcyclists (2.84) at $\alpha = 0.01$. It means that automobile drivers will reduce their private vehicle usage

more than motorcyclists in case of fuel price rise. The further investigation finds that automobile drivers will reduce their private vehicle usage significantly more than motorcyclists for all individual activities included in UR scale except “sending/taking family members” in response to fuel price rise (see Table 5). The results also indicate that automobile drivers have higher intention to decrease their car usage than motorcyclists’ motorcycle usage.

From the statistics shown in Table 5, we could find that automobile drivers would like to decrease more their car usage on trips for non-destination cruising around the streets without any specific purpose, participating in recreational activities, and necessary for multi-stop activities. We also found that most automobile drivers wouldn’t like to decrease their car usage on the trips for sending/taking family members and shopping. As to motorcyclists, they would like to decrease more trips for non-destination cruising around the streets without any specific purpose and for participating in recreational activities in case of fuel price rise. On the other hand, motorcyclists would decrease less their motorcycle usage on trips for commuting and multi-stop activities.

Table 5 Differences of private vehicle usage reduction between automobile drivers and motorcyclists

Trips to accomplish following Activities	Mean Score (S.D.)	
	Drivers	Riders
Trips for commuting	3.69*(1.79)	2.35(1.65)
Trips for work or business visit	3.69*(1.63)	2.72(1.62)
Trips for multi-stop activities	3.80*(1.53)	2.57(1.58)
Trips for recreational activities	4.00*(1.47)	3.33(1.66)
Trips for shopping	3.14*(1.60)	2.76(1.60)
Trips with time pressure (not including commuting)	3.76*(1.50)	2.91(1.59)
Trips for occasional travel requirements	3.75*(1.50)	2.69(1.55)
Trips for non-destination cruising around the streets without any specific purpose	4.28*(1.65)	3.51(1.81)
Trips for sending/taking family members	3.01(1.60)	2.68(1.57)
Mean score of latent variable for UR	3.68*(1.63)	2.84(1.66)

* Significantly higher at $\alpha = 0.01$

4. DISCUSSIONS

This study verified that the agents of socialization would affect people’s willingness to reduce their private vehicle usage through personal norm and personal norm could effectively enhance the degree of decreasing private vehicle usage in response to fuel price rise. ACE is the only one agent that has significant effect on personal norm for both two study groups. It indicates that people’s private vehicle usage could be effectively reduced through education in school. Thus, well-designed educational programs are suggested to teach the impact of using private vehicles on environmental pollution to the young students in school.

MM-PEER affects PN significantly for motorcycle riders, but not for automobile drivers. This might be the case that is related to illegal motorcycle riding of teenagers in Taiwan. A significant proportion of people in Taiwan have motorcycle riding experience before they start to use automobile. More than 60% of people even have illegal motorcycle riding when aged less than 18 (Yeh et al., 2005). For MM-PEER was most incubated during school life in which using motorcycle is the hot issue and common language for teenagers in Taiwan and a lot of education programs intervene in motorcycle usage for high school students, it might result in deep recognition on the impact of motorcycle usage and personal norm towards environmental friendly traveling mode. On the contrary, most people start their automobile usage after leaving school. It might lose the opportunity to incubate MM-PEER to affect their person

norm towards environmental friendly traveling mode.

On the other side, PA toward automobiles would affect their children's PN, but not for motorcycle riders. This phenomenon might be explained by the ownership of private vehicle. Most Taiwanese start to use automobiles after leaving school and the first automobile they use are usually owned by their parents. When the fresh drivers want to use automobiles, they usually need to inquire their parents' opinions. Thus, children's mind about automobile usage might be affected by their parents' attitude toward automobile usage. In contrast, people could have their own motorcycle more easily than having their own automobiles after leaving school. They could decide to use motorcycle by themselves and wouldn't need to ask their parents. Thus, PA toward motorcycles has no significant influential effect on motorcyclists' PN toward environmental friendly traveling modes. Besides, enforcing ACE to students could significantly reduce people's private vehicle usage.

This study computed the latent variables of UR and PN, compared the mean values of UR and PN between automobile drivers and motorcyclists, and conducted some statistical analyses to explore private vehicle usage reduction for the two groups in response to fuel price rise. Both automobile drivers and motorcyclists were found to be more likely to reduce their private vehicle usage on the trips for recreational or non-destination cruising around. Automobile drivers wouldn't like to reduce their car usage on trips for sending/take family members and shopping. It might be the case that automobile drivers need space to seat their goods and passengers, which couldn't be conveniently offered by public transportation. Furthermore, motorcycle riders wouldn't like to reduce their motorcycle usage for commuting and multi-stop activities. It might be the case that traffic congestion, convenient parking and low operating cost make the motorcycles an attractive mode for commuting or achieving multi-stop activities.

However, attention should be focused on the activities that people wouldn't like to decrease their vehicle usage even when fuel price rises. Drivers wouldn't like to decrease their car use on trips for picking family members and shopping. It might be the reason that drivers need space to carry their goods or send/pick up their family members that other modes couldn't offer convenient and inexpensive service for their demand. On the other hand, riders wouldn't like to decrease motorcycle use for commuting to workplace and for multi-stop activities. The reason might be that people are used to ride motorcycles for commuting and motorcycles are more suitable for multi-stop traveling than other travel modes in Taiwan. It implies that different transportation demands need different services to prevent them from using private vehicles. For example, providing more convenient and inexpensive alternatives for commuting might be more effective than rising fuel price for decreasing motorcycle usage.

Besides, the mean values of most items of UR and PN are found to have significant differences between automobile drivers and motorcycle riders. It means that automobile drivers are more sensitive to fuel price rise than motorcycle riders. However, both automobile drivers and motorcycle riders have low intention to reduce their private vehicle usage to send/take their family members when the fuel price rises. It might be the case that no convenient, inexpensive, and accessible public feeder transportation to serve "the first and last mile" of the home-based trips. Therefore, providing well-designed public transportation network with convenient and safe feeder service might be an effective solution to stop people using private vehicle to send/take their family members. Furthermore, automobile drivers have significantly higher values for all items of PN variable than motorcycle riders. It indicates that automobile drivers tend to have higher recognition about environmental protection and are more likely to reduce their private vehicle usage than motorcyclists. On the other side, motorcycle riders might think the pollution produced by motorcycles is not severe and have lower personal norm. It also implies that the impact of motorcycle usage on fuel

consumption and environment pollution is underestimated. Enhancing education about the environmental impact of motorcycle usage in school is required in order to increase riders' personal norm of using environmental friendly traveling modes.

5. CONCLUSION

Personal norm towards environmental friendly transportation modes would affect people's automobile and motorcycle usage. Increasing the awareness about environmental protection through school education is found to have significant effect on reducing both automobile and motorcycle usage in response to fuel price rise. Thus, enhancing the environment education program in school would be a complementary force to reduce private vehicle usage in addition to fuel price rise.

Parents' attitude towards automobile usage has significant effect on their children's personal norm on automobile usage, and peers' attitude toward environmental friendly traveling modes is also found to have significant effect on personal norm toward environmental friendly traveling modes and then determine motorcyclists' motorcycle usage reduction in response to fuel price rise. This study only verified the agents that would affect children's private vehicle usage in the future. Therefore, how to change parents' attitude toward environmental friendly traveling modes and how to influence peers' attitude toward environmental friendly traveling modes through school education are expected to be explored in further study.

Moreover, automobile drivers and motorcycle riders have different demand for different activities to use their private vehicles and will have different levels of vehicle usage reduction in responses to fuel price rise. Different complementary strategies are suggested to combine with fuel price rise in order to achieve the objective of reducing private vehicle usage effectively. Finally, this study was limited to explore the influential factors that affect children's personal norm about private vehicle usage before 18, further research could be extended to investigate how social agents affect personal norm after people got their driving/riding licenses.

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